



Australian Government
Bureau of Meteorology



Ingesting VIIRS SST into the Bureau of Meteorology's Operational SST Analyses

Helen Beggs, Lixin Qi, Pallavi Govekar and Christopher Griffin

Bureau of Meteorology, Melbourne, Australia

21st GHRSSST Science Team Meeting, Virtual, 1st – 4th June 2020





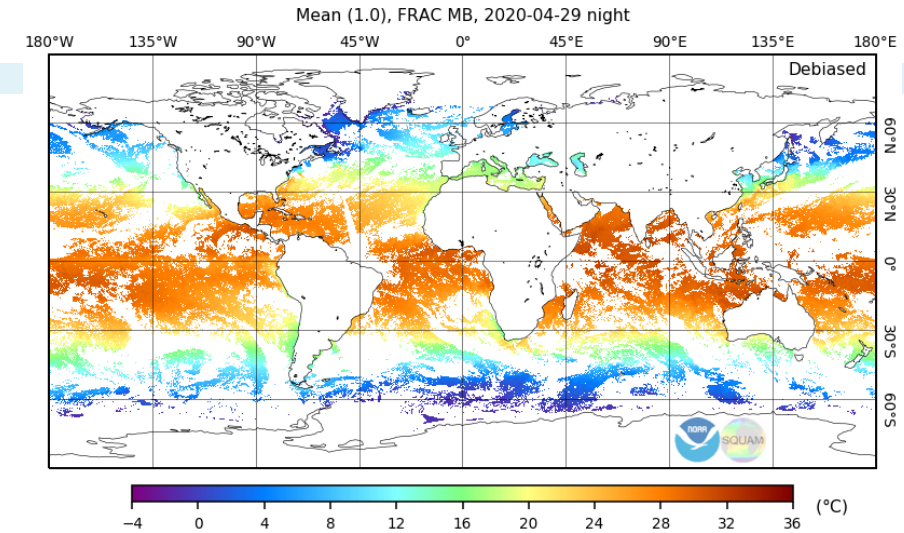
Australian Government

Bureau of Meteorology

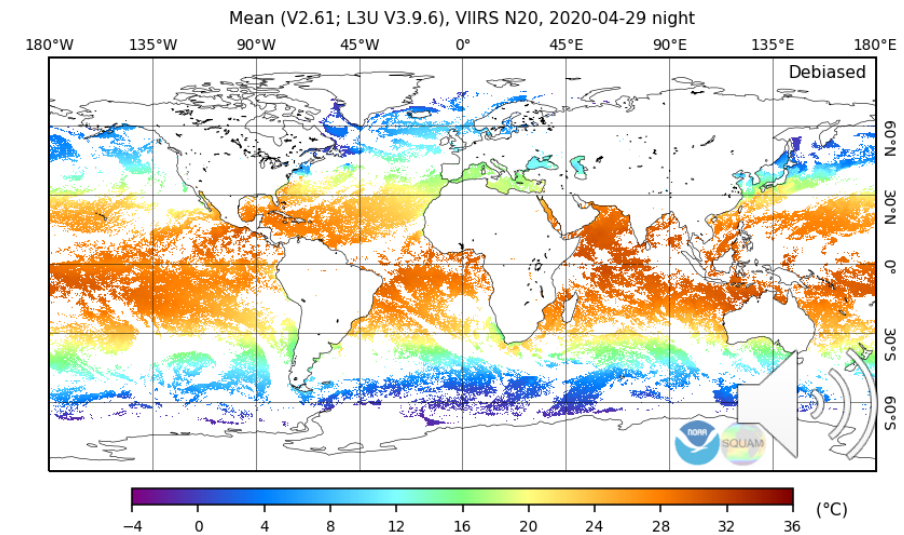
Overview

- Since 2007, the Bureau has produced operational, statistically interpolated analyses of SST observations from microwave and infrared sensors on polar-orbiting satellites and in situ platforms
- VIIRS infrared radiometers on Suomi-NPP and NOAA-20 provide SST at higher spatial resolution (0.75 – 1.5 km) and swath width than AVHRR infrared radiometers (1.1 – 4 km).
- NOAA produces ACSPO VIIRS SST products in GHRSSST L2P (swath) and 0.02° gridded L3U format
- **From 17 Nov 2019:** ACSPO Suomi-NPP and NOAA-20 VIIRS L3U SSTs have been ingested into the Bureau's daily regional SST analysis (RAMSSA)
- **From 29 April 2020:** VIIRS L3U SSTs have been ingested into the Bureau's daily global SST analysis (GAMSSA)

MetOp-B FRAC AVHRR



NOAA-20 VIIRS





Australian Government
Bureau of Meteorology

Daily Regional and Global Multi-Sensor SST analyses (RAMSSA and GAMSSA)

<http://www.bom.gov.au/marine/sst.shtml>

Resolution: Daily $1/12^\circ$ regional, $1/4^\circ$ global

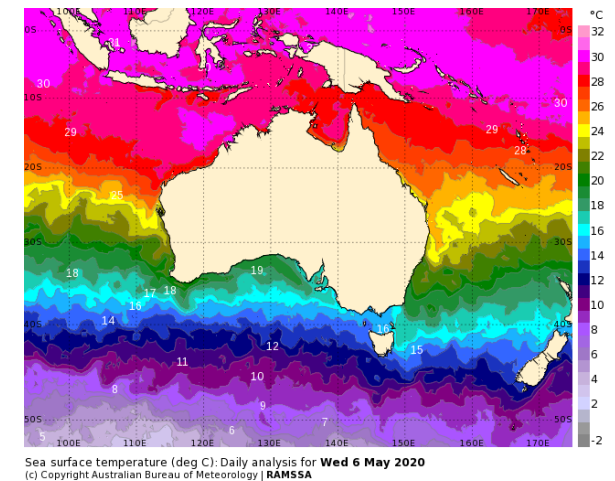
Method: Optimal interpolation ([Beggs et al., 2011, AMOJ, 61](#))

Estimate of foundation SST derived by removing observations where NWP wind speeds < 6 m/s (day) and < 2 m/s (night)

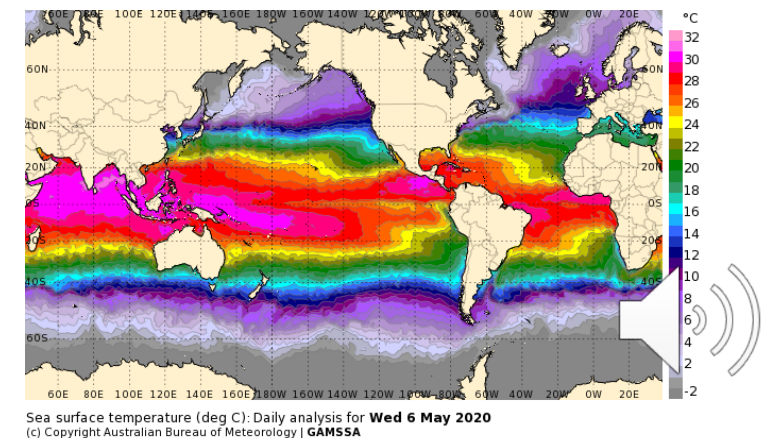
Inputs: QL = 5; sses_bias subtracted (except AMSR2)

- NAVOCEANO 9 km GAC AVHRR (METOP-A/B) L2P SST
- JAXA 50 km AMSR2 (GCOM-W) L2P SST
- NOAA ACSPO $1/50^\circ$ VIIRS L3U (NOAA-20, NPP) SST
 - Thinned to $1/3^\circ$ for RAMSSA and $1/2^\circ$ for GAMSSA
- In situ ship and buoy SST (GTS)
- NCEP $1/12^\circ$ Sea Ice Analyses
- NWP 24 hour forecast wind speeds (BoM ACCESS-G3)

RAMSSA L4 SSTfnd (6 May 2020)



GAMSSA L4 SSTfnd (6 May 2020)





Australian Government
Bureau of Meteorology

Daily Regional and Global Multi-Sensor SST analyses (RAMSSA and GAMSSA)

<http://www.bom.gov.au/marine/sst.shtml>

Available: 2006 to present in GHRSSST GDS2.0 L4 format

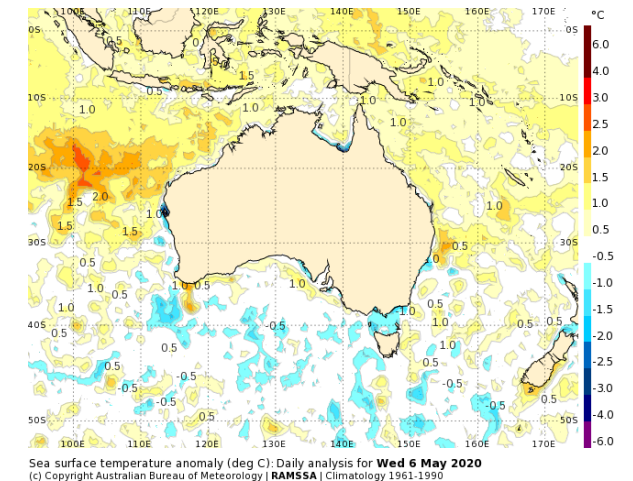
Uses:

- NWP models: QC radiances and ocean boundary condition
- Seasonal prediction models: Initialise POAMA2, ACCESS-S2
- Ocean models: Validating OceanMAPS
- Public Weather Maps (MetEye), Weather forecasting
- Nowcasting Marine Heat Waves, GHRSSST Multi-Product Ensemble

Access:

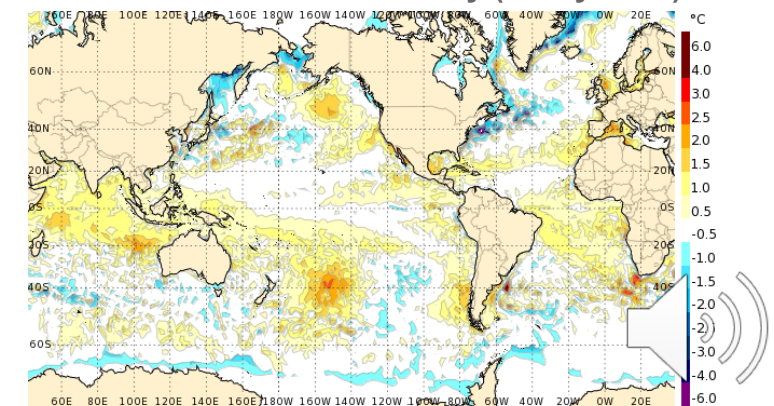
- <http://portal.aodn.org.au> (search for RAMSSA, GAMSSA)
- <https://podaac.jpl.nasa.gov> (search for RAMSSA, GAMSSA)

RAMSSA L4 SST Anomaly (6 May 2020)



Sea surface temperature anomaly (deg C): Daily analysis for Wed 6 May 2020
(c) Copyright Australian Bureau of Meteorology | RAMSSA | Climatology 1961-1990

GAMSSA L4 SST Anomaly (6 May 2020)



Sea surface temperature anomaly (deg C): Daily analysis for Wed 6 May 2020
(c) Copyright Australian Bureau of Meteorology | GAMSSA | Climatology 1961-1990

RAMSSA/GAMSSA System Configuration

Op and Test 13 Feb – 28 Apr 2020, Op = Test from 29 Apr 2020

	Operational GAMSSA	Test GAMSSA	Operational RAMSSA	Test RAMSSA
Satellite SST Inputs	NAVO GAC AVHRR (MA, MB) JAXA AMSR-2	NAVO GAC AVHRR (MA, MB) JAXA AMSR-2 ACSPO VIIRS L3U (NPP, N20)	NAVO GAC AVHRR (MA, MB) JAXA AMSR-2 ACSPO VIIRS L3U (NPP, N20)	NAVO GAC AVHRR (MA, MB) JAXA AMSR-2 ACSPO VIIRS L3U (NPP, N20)
In situ SST Inputs	Buoys and Ships (from GTS)	Buoys and Ships (from GTS)	Buoys, ships, Argo, XBT, CTD (GTS)	Buoys, ships, Argo, XBT, CTD (GTS)
Sea-ice Inputs	NCEP 1/12° sea ice analysis	NCEP 1/12° sea ice analysis	NCEP 1/12° sea ice analysis	NCEP 1/12° sea ice analysis
Wind speed Inputs	ACCESS-G2 3-hourly 2°	ACCESS-G3 3-hourly 2°	ACCESS-R2 hourly 1°	ACCESS-G3 hourly 1°
Obs. Correlation Length Scale (km)	20	20	12	12
BG Correlation Length Scale (km)	50	80	50	50
Obs Estimated STD (OBSESD)	Calculated from 1-31 Oct 2014 satellite SST vs Buoy statistics	Calculated from 1-31 Dec 2019 satellite SST vs Buoy statistics	Calculated from 16 Mar – 4 Apr 2017 satellite SST vs Buoy statistics	Calculated from 1-31 Dec 2019 satellite SST vs Buoy Statistics
Background Field	Previous day's GAMSSA plus Reynolds and Smith (1994) climatology	Previous day's GAMSSA plus BoM Global Weekly 1° SST	Previous day's RAMSSA plus BoM Global Weekly 1° SST	Previous day's RAMSSA plus BoM Global Weekly 1° SST





Satellite SSTfnd(t) – Buoy SSTfnd(t) 1 – 31 Dec 2019

Data collocated if within same RAMSSA grid cell, and winds > 6 m/s (day), > 2 m/s (night).

Sensor	Australian Matchups	Australian Bias (K)	Australian STD (K)	Obs Estimated STD (OBSESD) (K)
AVHRR (MetOp-A)	14315	0.079	0.457	0.54
AVHRR (MetOp-B)	12774	0.052	0.496	0.55
AMSR2 (GCOM-W)	134141	0.162	0.536	0.70
VIIRS (Suomi-NPP)	4113	-0.037	0.363	0.40
VIIRS (NOAA-20)	4276	-0.019	0.362	0.38

From 29 Apr 2020 VIIRS SST has much higher weight in RAMSSA and GAMSSA than other satellite data streams – and same weight as buoy data (OBSESD 0.4 K)





Analysis SSTfnd($t - 1$) – Buoy SSTfnd(t)

13 Feb – 28 Apr 2020

Data collocated if within same RAMSSA grid cell, and winds > 6 m/s (day), > 2 m/s (night).

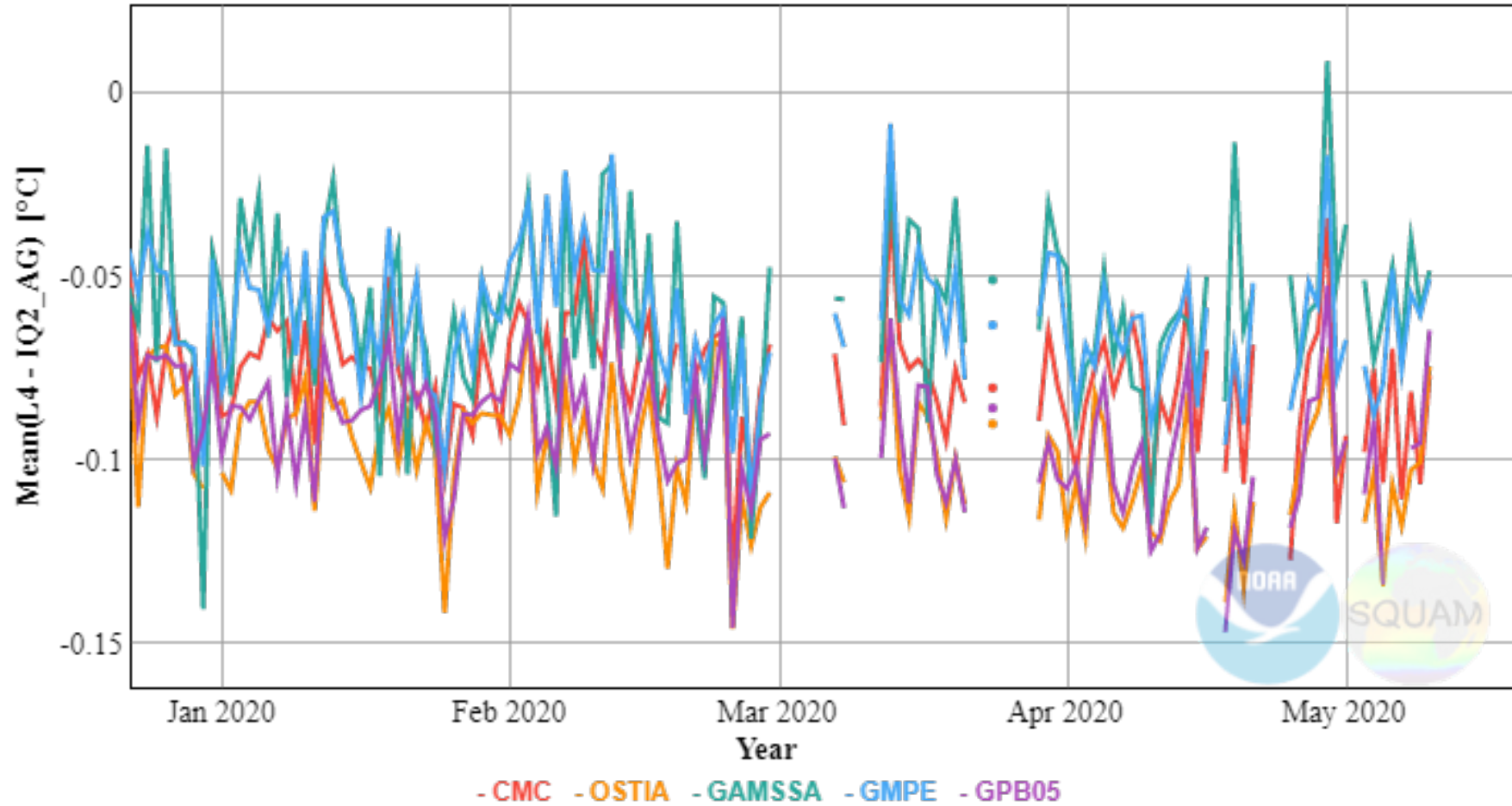
Analysis	Global Matchups	Global Bias (K)	Global STD (K)	Australian Matchups	Australian Bias (K)	Australian STD (K)
Op RAMSSA (inc NPP/N20 VIIRS)				85189	0.127	0.670
Test RAMSSA (inc NPP/N20 VIIRS)				88782	0.112	0.654
Op GAMSSA	214165	0.056	0.647			
Test GAMSSA (inc NPP/N20 VIIRS)	214082	0.063	0.662			
CMC 0.1deg (inc NPP VIIRS)	343463	0.037	0.627	74826	0.061	0.627

Test RAMSSA STD ↓ 0.016 K, Test GAMSSA STD ↑ 0.015 K



Mean (GAMSSA minus Argo SST)

L4 - IQ2_AG



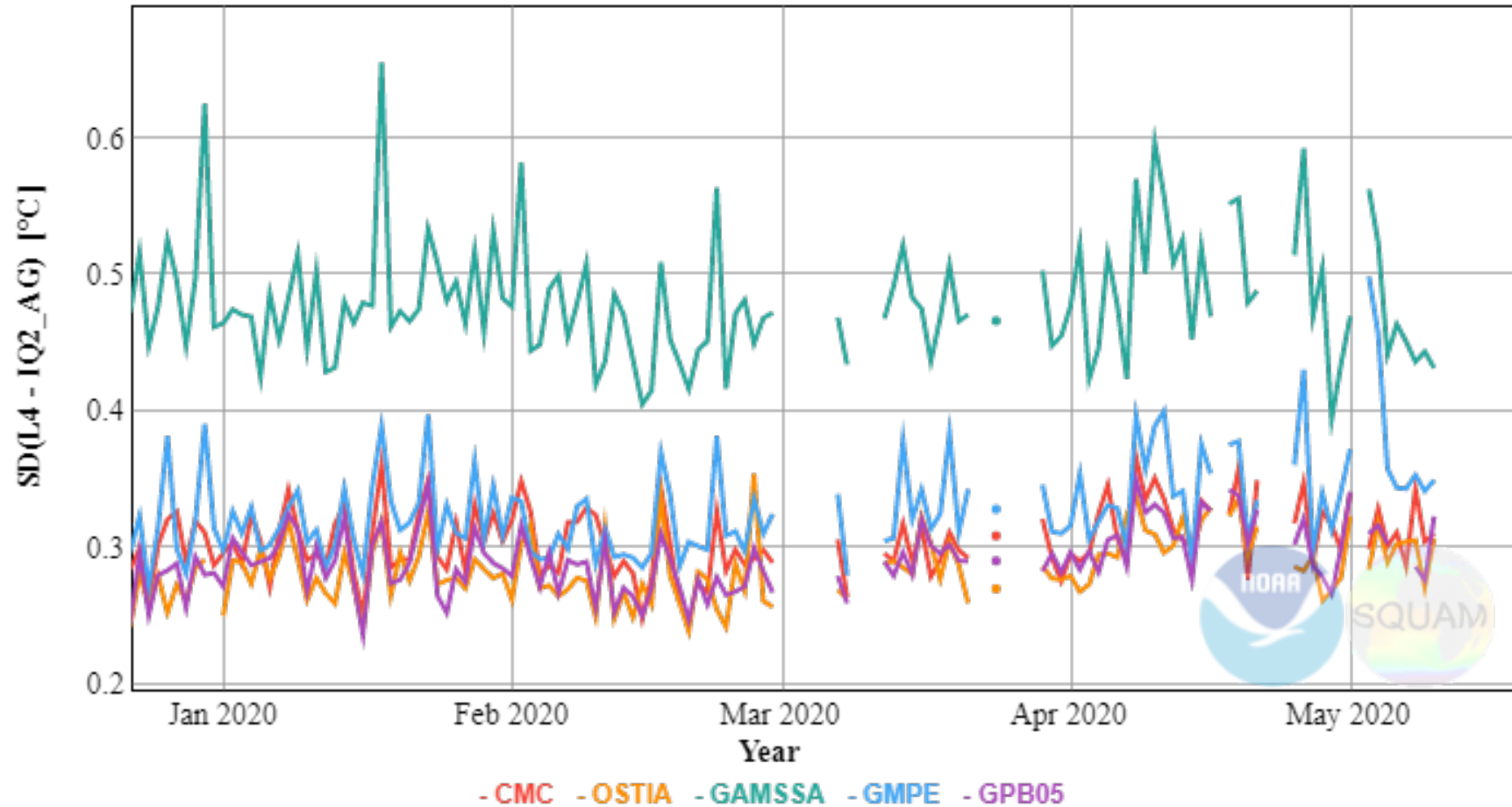
Ingesting VIIRS data from 29 April caused no increase to GAMSSA bias

<https://www.star.nesdis.noaa.gov/socd/sst/squam/analysis/I4/>



STD (GAMSSA minus Argo SST)

L4 - IQ2_AG



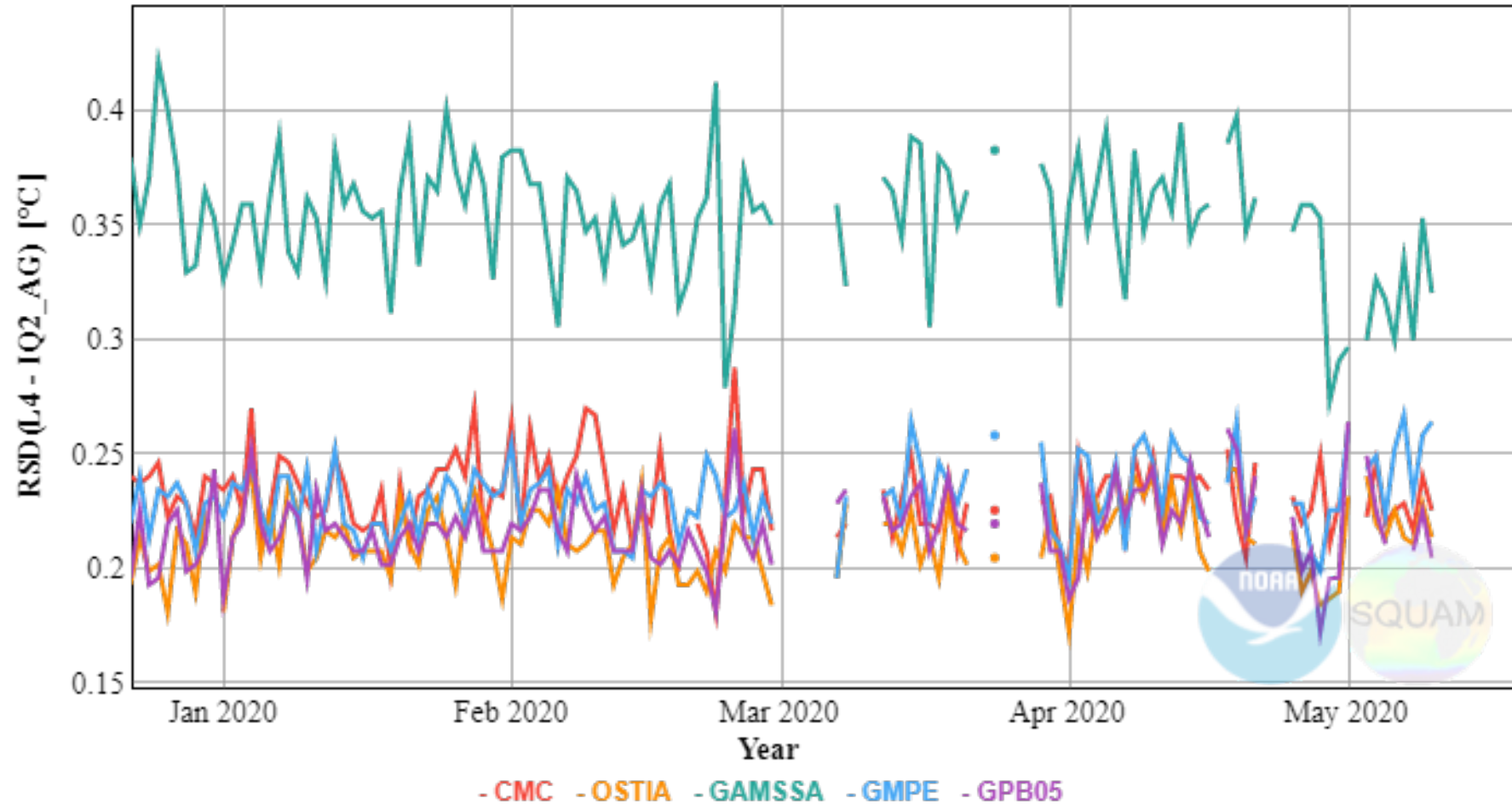
Ingesting VIIRS data from 29 April caused no increase to GAMSSA STD

<https://www.star.nesdis.noaa.gov/socd/sst/squam/analysis/I4/>



RSD (GAMSSA minus Argo SST)

L4 - IQ2_AG



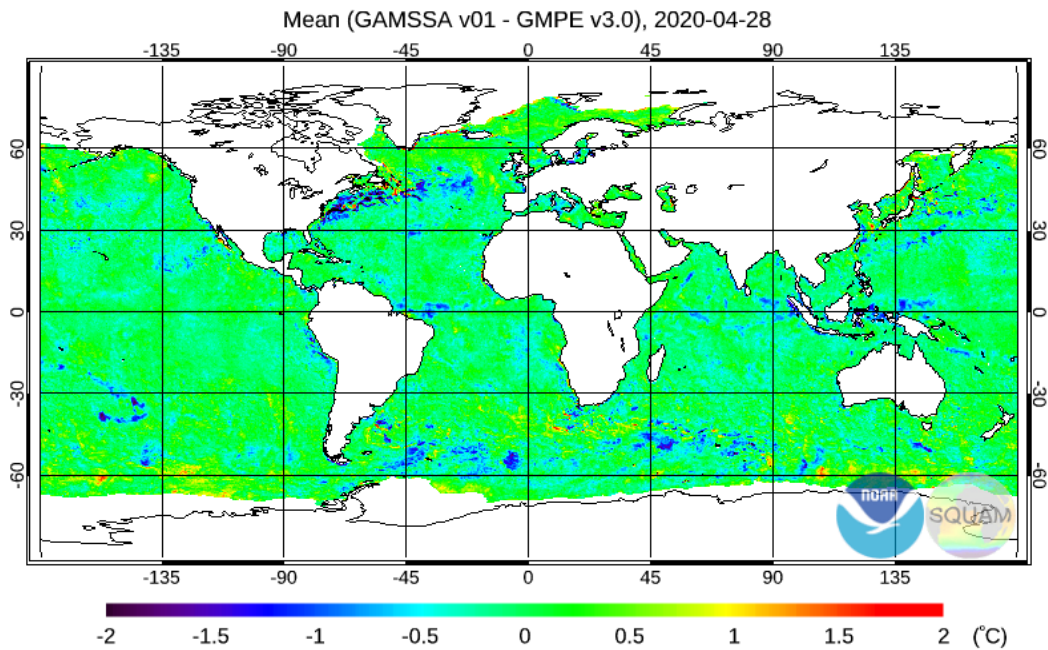
Ingesting VIIRS data from 29 April caused GAMSSA RSD ↓ 0.03 K

<https://www.star.nesdis.noaa.gov/socd/sst/squam/analysis/I4/>

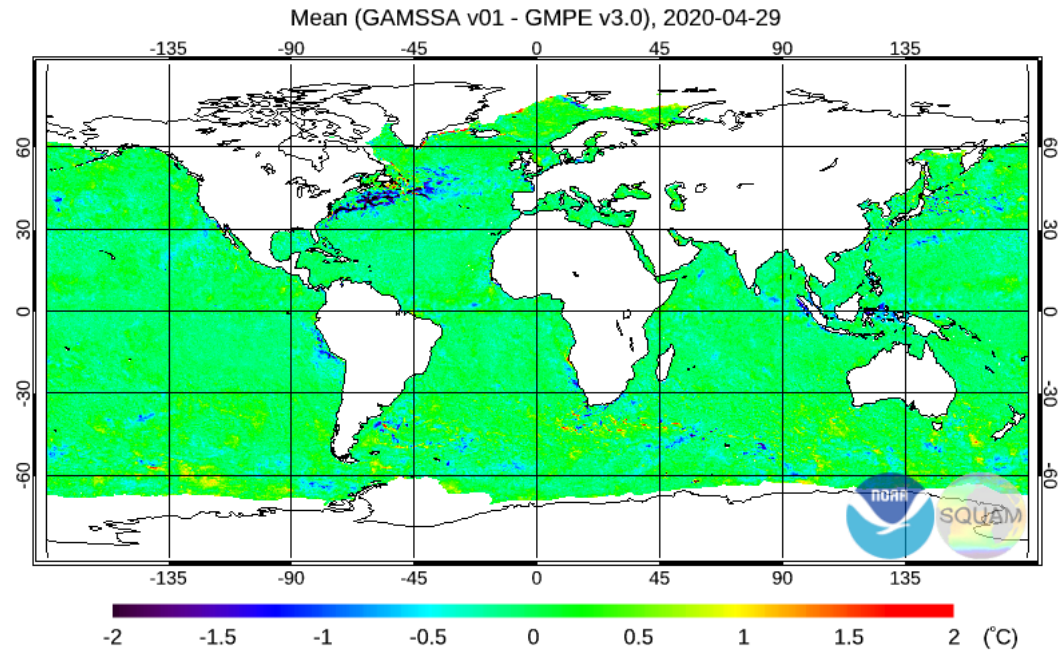


Operational GAMSSA pre and post upgrade Minus GHRSSST Multi-Product Ensemble

28 Apr 2020



29 Apr 2020

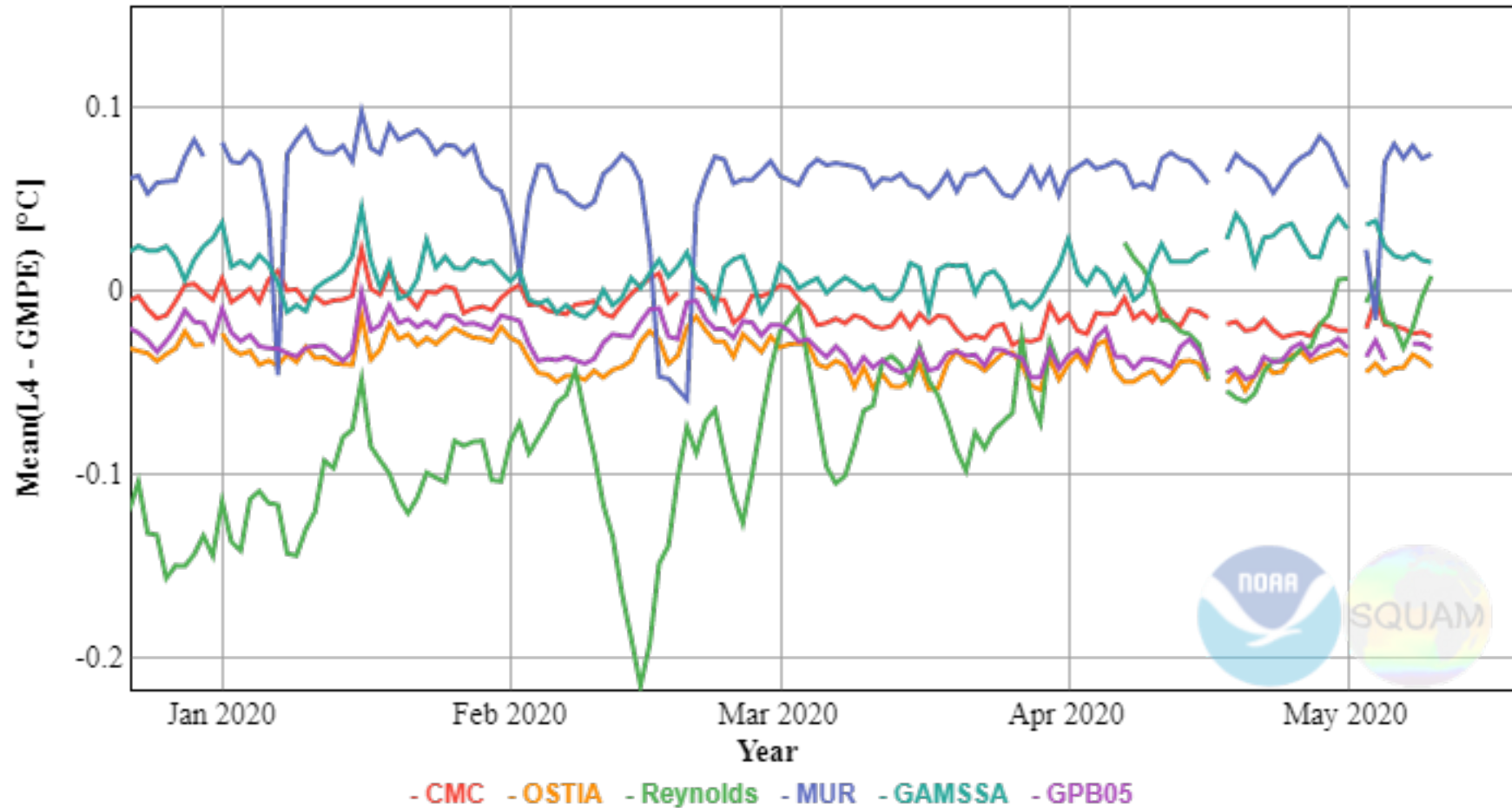


<https://www.star.nesdis.noaa.gov/socd/sst/squam/analysis/l4/>



Mean (GAMSSA minus GMPE SST)

L4 - GMPE



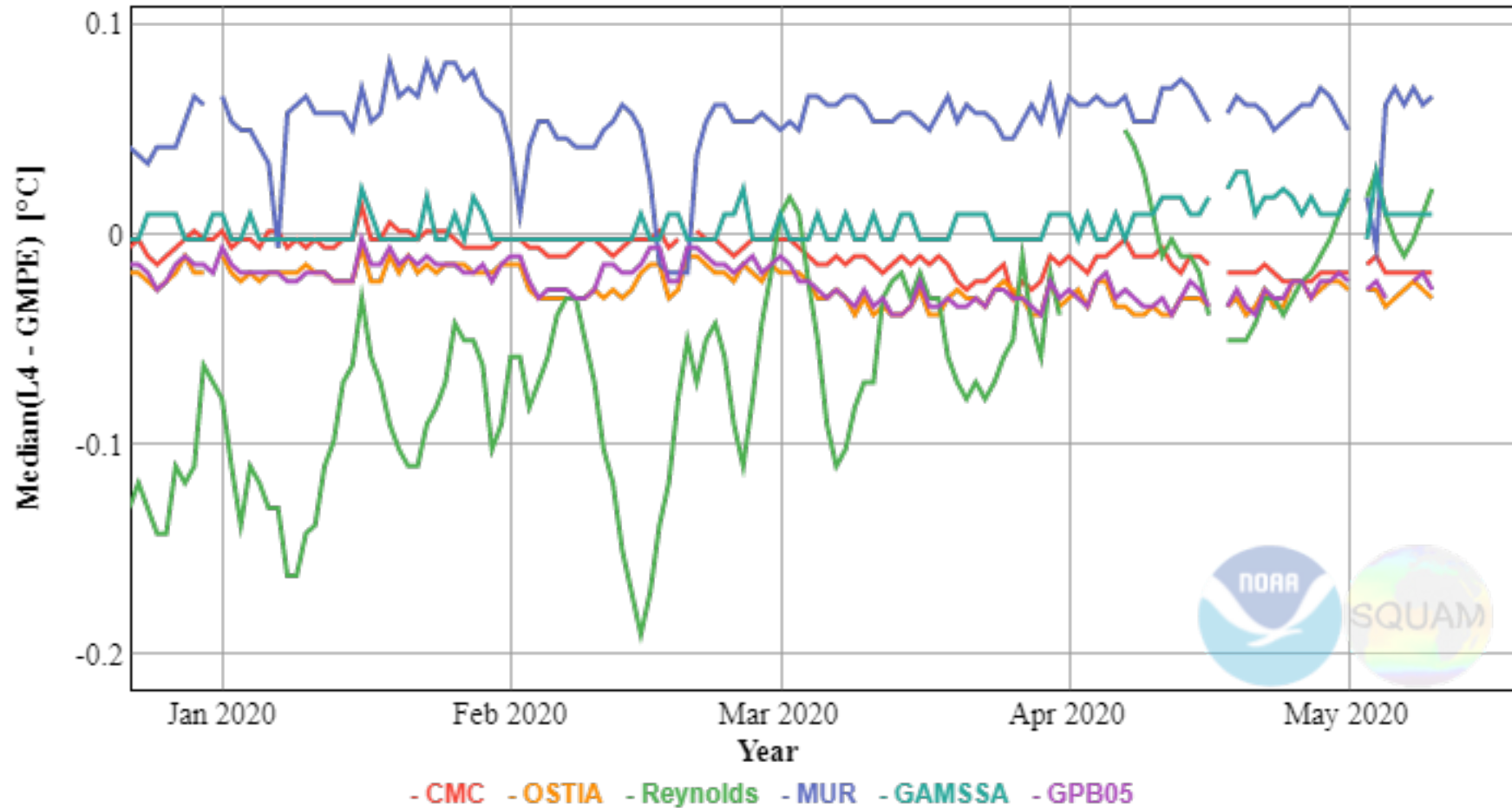
Ingesting VIIRS data from 29 April caused no increase in GAMSSA bias

<https://www.star.nesdis.noaa.gov/socd/sst/squam/analysis/I4/>



Median (GAMSSA minus GMPE SST)

L4 - GMPE

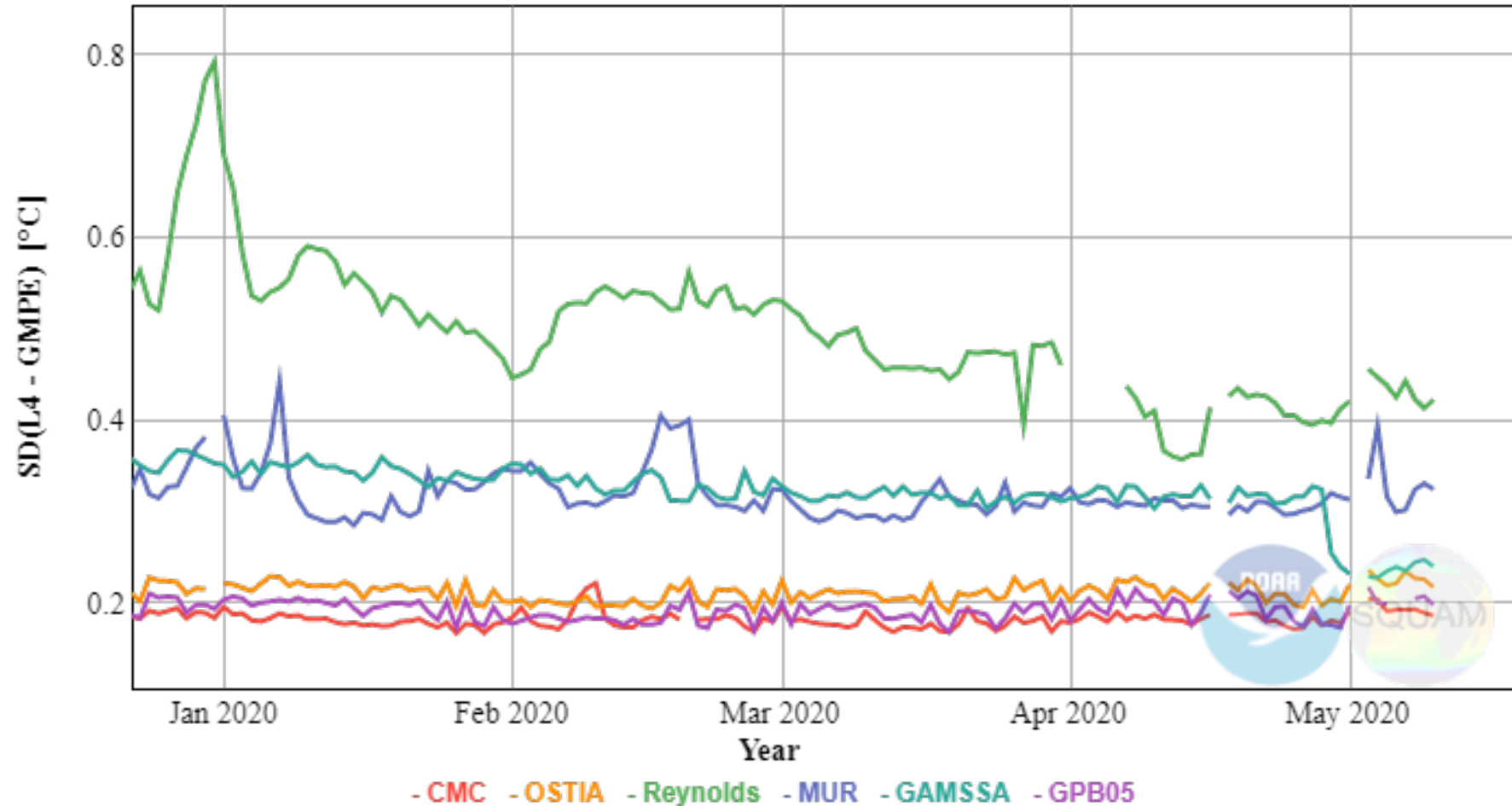


Ingesting VIIRS data from 29 April caused no increase in GAMSSA Median bias 

<https://www.star.nesdis.noaa.gov/socd/sst/squam/analysis/l4/>

STD (GAMSSA minus GMPE SST)

L4 - GMPE



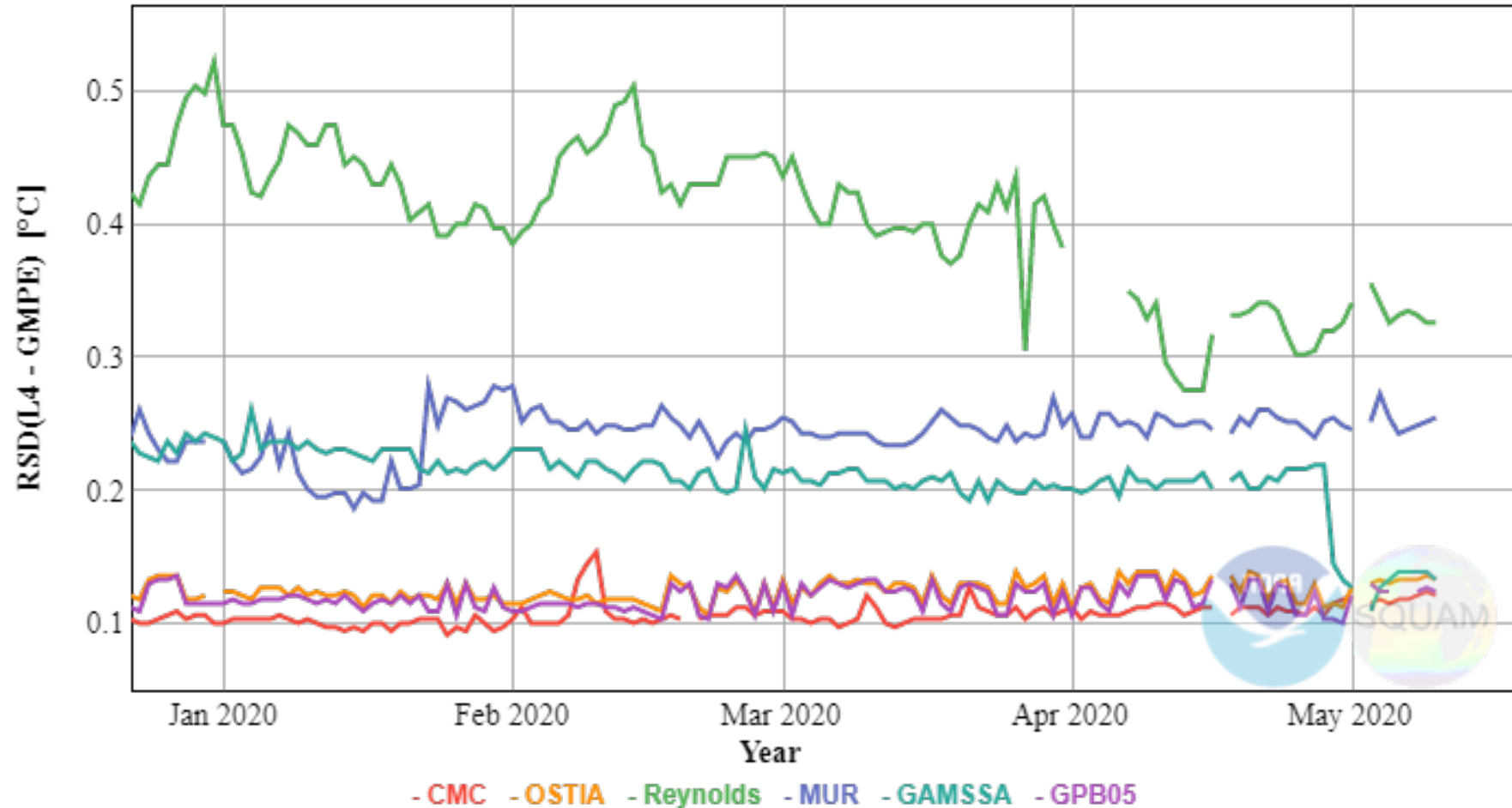
Ingesting VIIRS data from 29 April caused GAMSSA STD ↓ 0.08 K

<https://www.star.nesdis.noaa.gov/socd/sst/squam/analysis/l4/>



RSD (GAMSSA minus GMPE SST)

L4 - GMPE



Ingesting VIIRS data from 29 April caused GAMSSA RSD ↓ 0.08 K

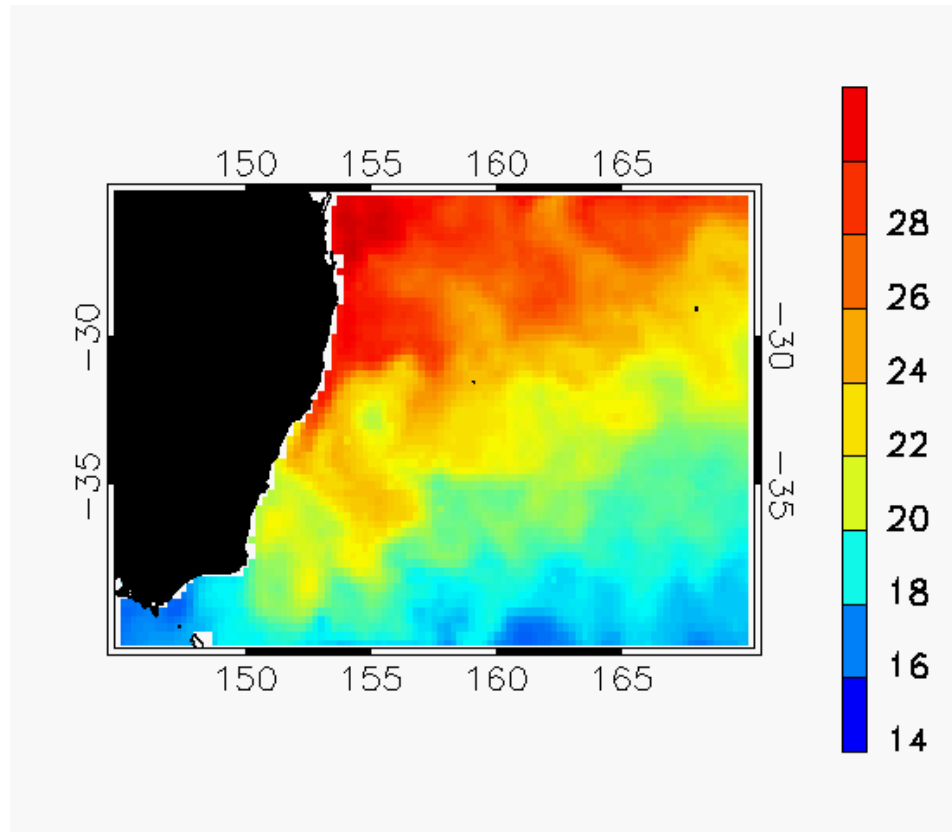
<https://www.star.nesdis.noaa.gov/socd/sst/squam/analysis/l4/>



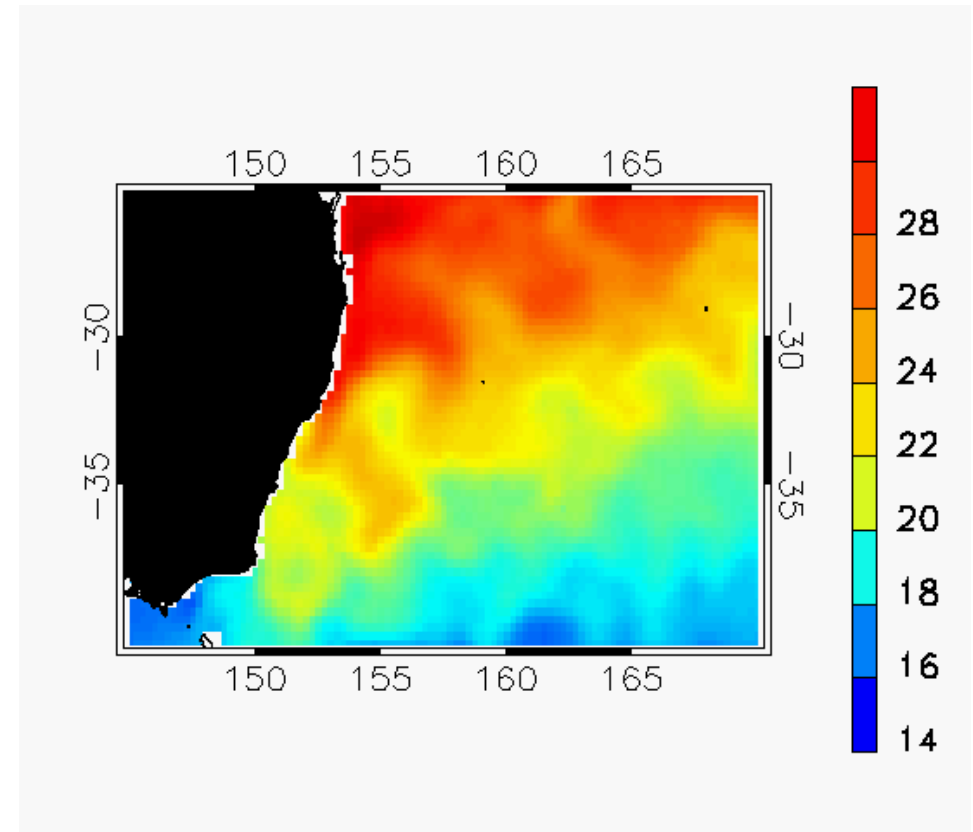
SST

1 Apr 2020

Operational GAMSSA (no VIIRS)



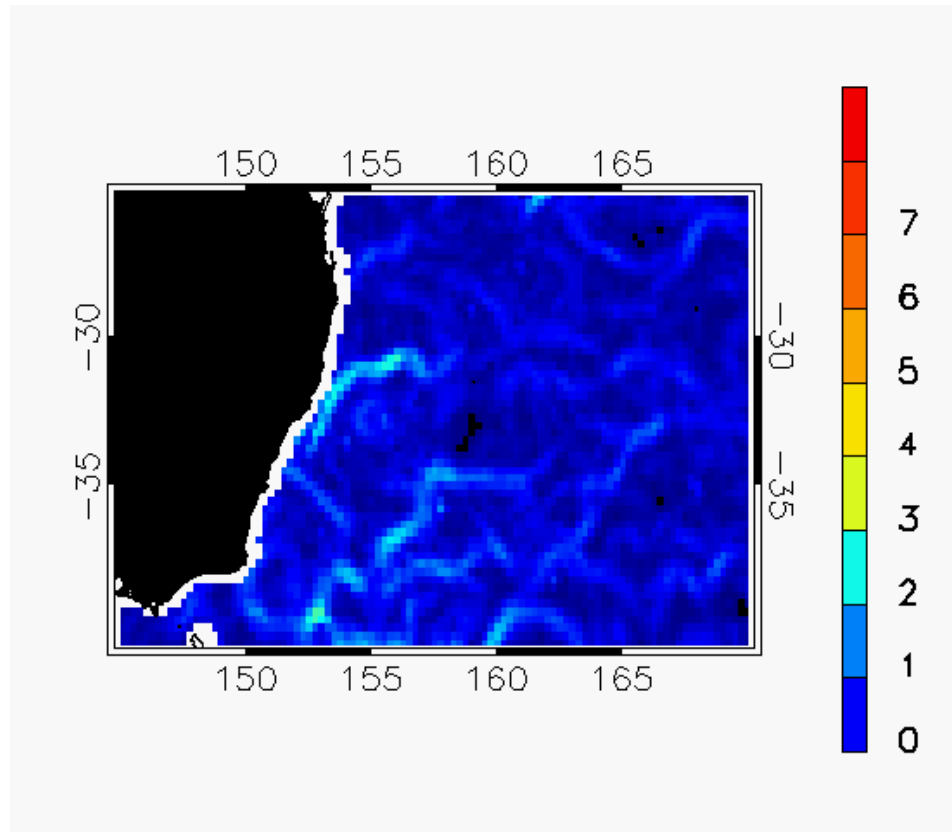
Test GAMSSA (with NPP/N20 VIIRS)



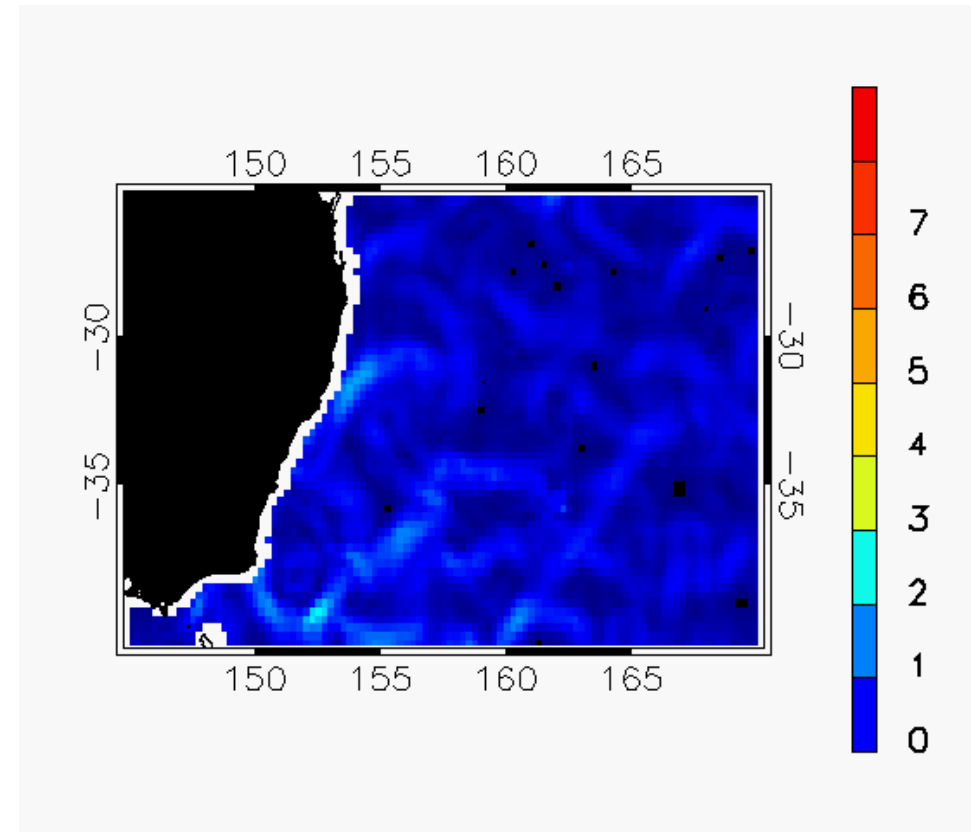
SST Gradients

1 Apr 2020

Operational GAMSSA (no VIIRS)



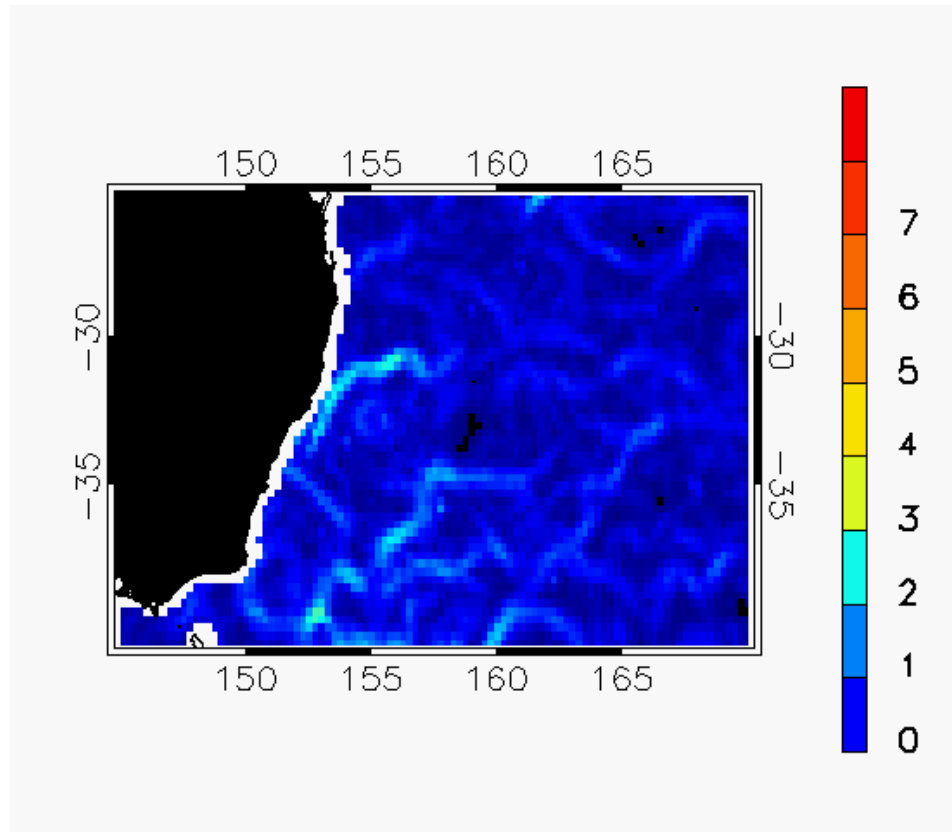
Test GAMSSA (with NPP/N20 VIIRS)



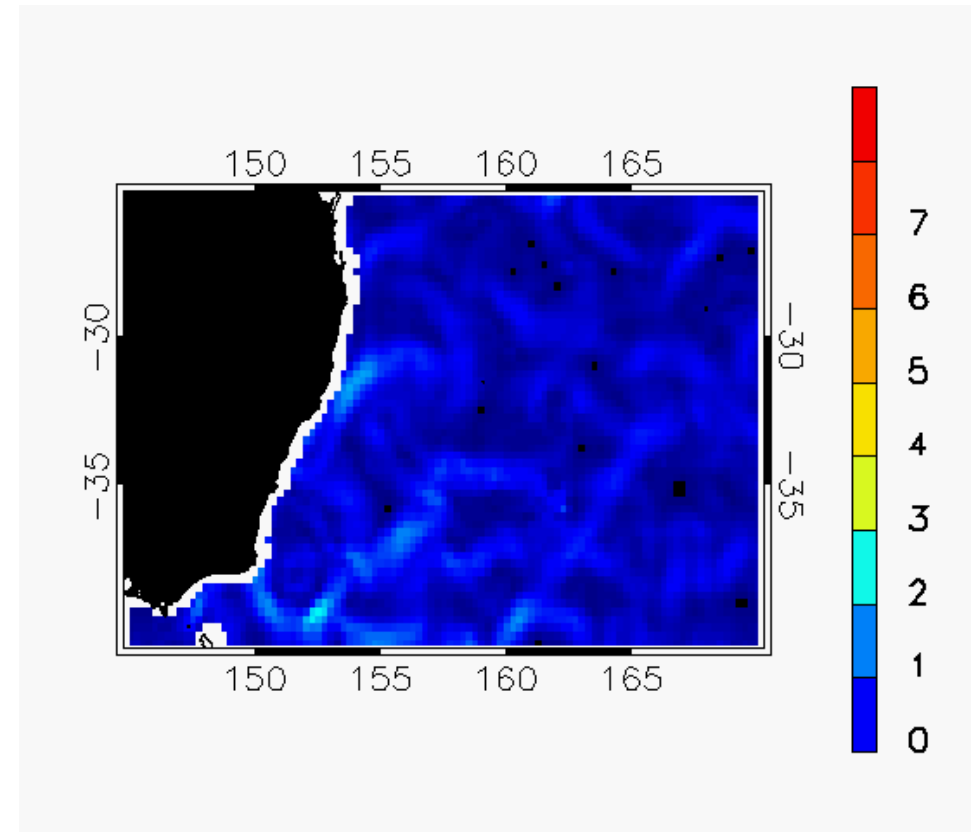
SST Gradients

1 – 30 Apr 2020

Operational GAMSSA (no VIIRS)



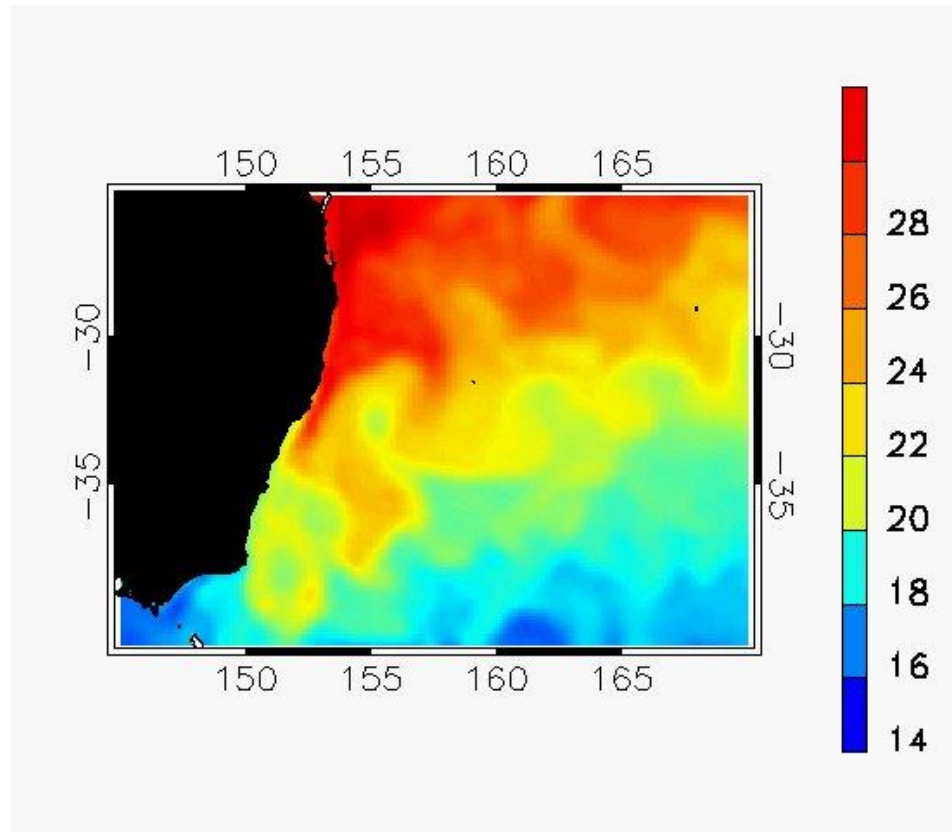
Test GAMSSA (with NPP/N20 VIIRS)



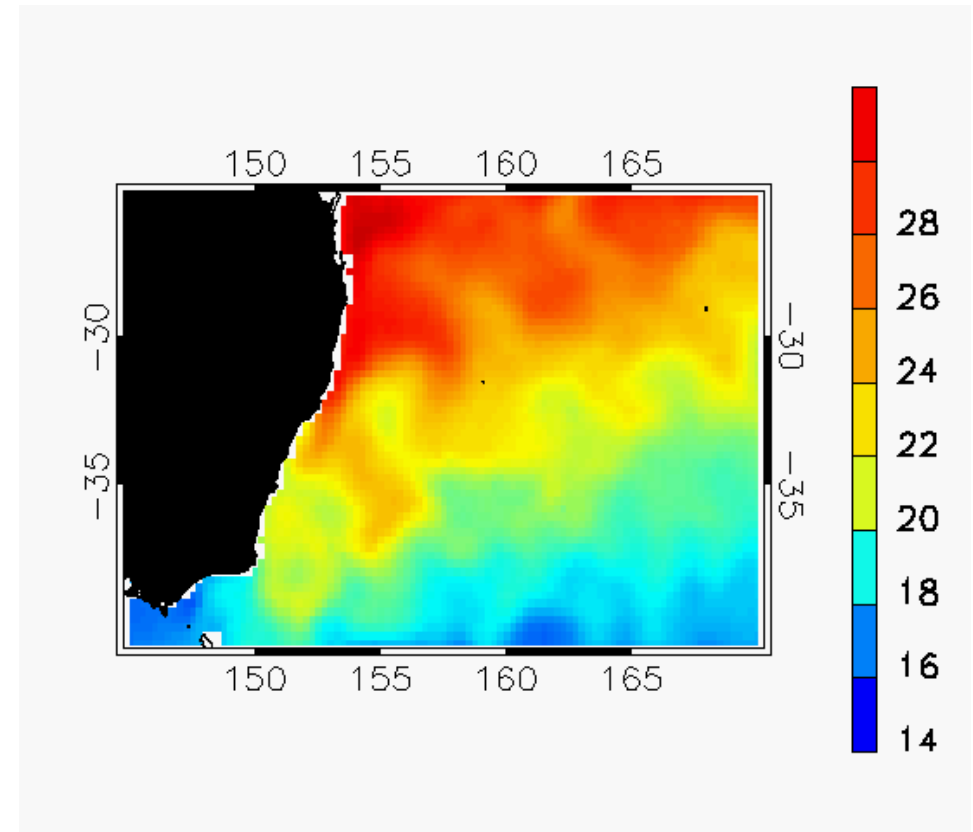
SST

1 Apr 2020

10 km CMC (with NPP VIIRS)



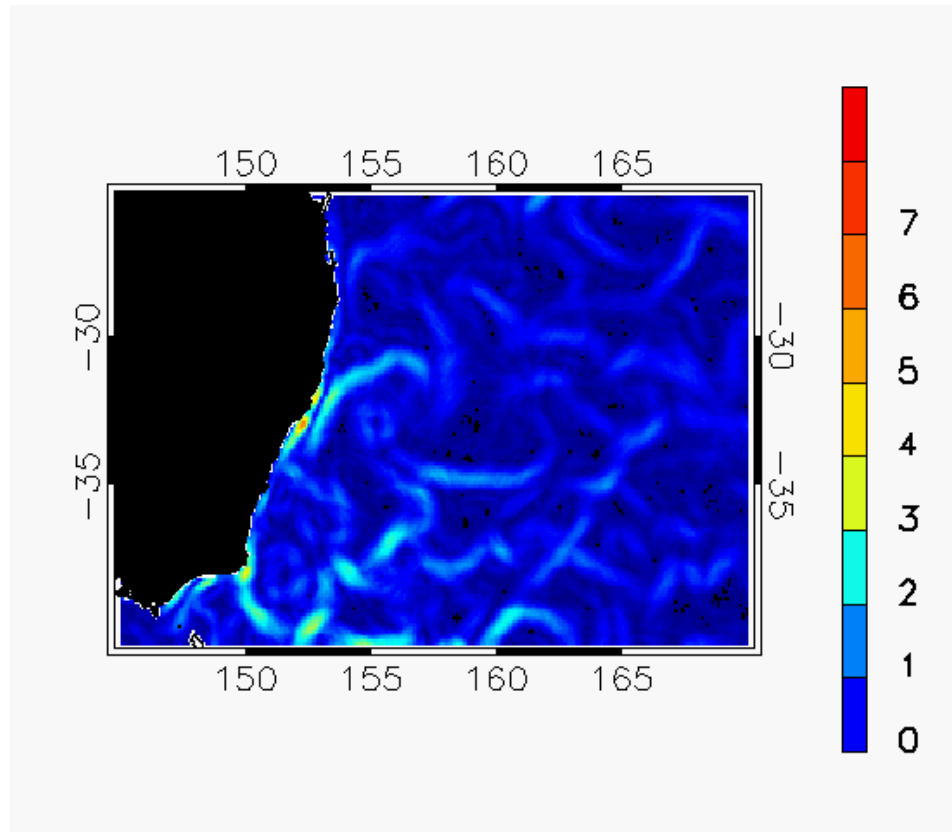
Test 25 km GAMSSA (with NPP/N20 VIIRS)



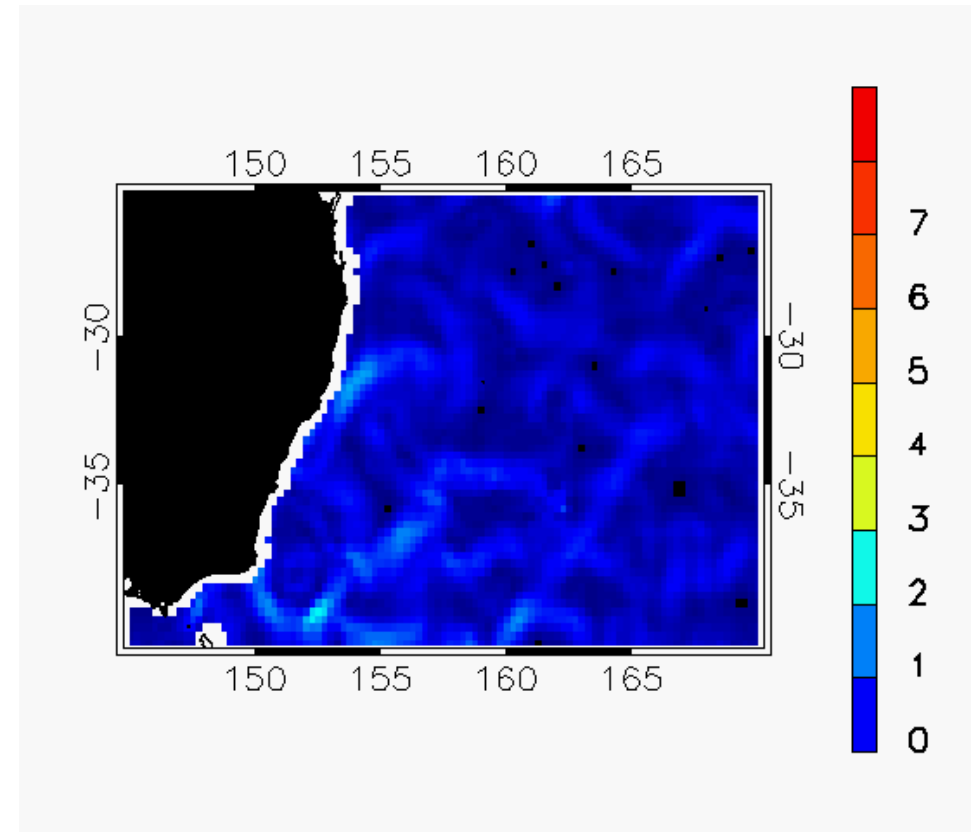
SST Gradients

1 Apr 2020

10 km CMC (with NPP VIIRS)



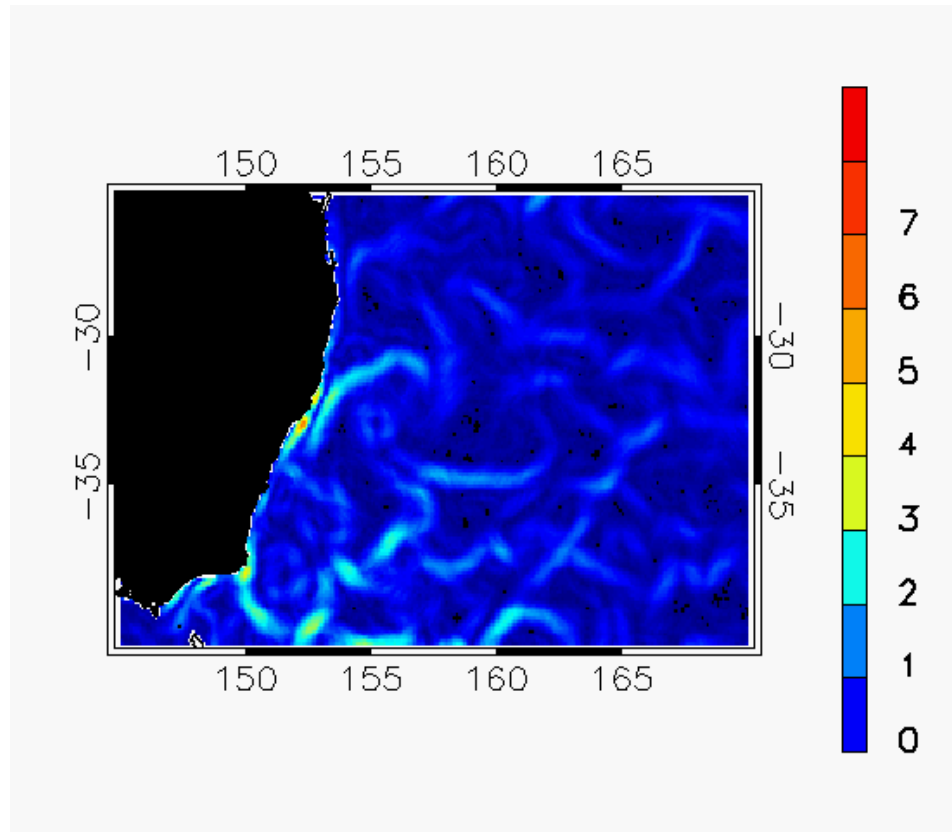
Test 25 km GAMSSA (with NPP/N20 VIIRS)



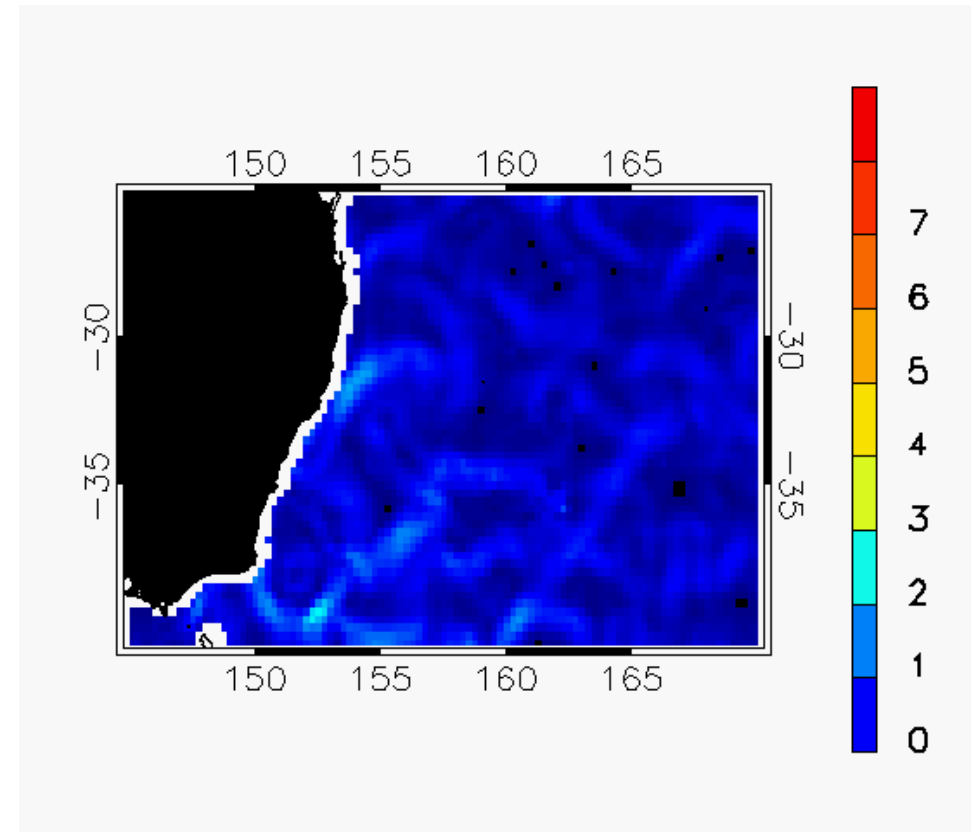
SST Gradients

1 – 30 Apr 2020

10 km CMC (with NPP VIIRS)



Test 25 km GAMSSA (with NPP/N20 VIIRS)





Australian Government

Bureau of Meteorology

Key Points

- NPP and NOAA-20 VIIRS SST ingested into operational RAMSSA from 17 Nov 2019
- Pre-Op RAMSSA innovation statistics for 17 Oct – 13 Nov 2019 show 0.002 K reduction in STD
- Updating OBSESD values and ACCESS-G3 winds on 29 Apr 2020 reduced RAMSSA STD by 0.016 K

- NPP and NOAA-20 VIIRS SST ingested into operational GAMSSA from 29 Apr 2020
- Pre-op GAMSSA vs buoy innovation statistics for 14 Feb – 28 Apr 2020 show 0.015 K increase in STD, but STD GAMSSA – Argo showed no increase from 29 Apr 2020
- RSD GAMSSA – Argo reduced by 0.05 K
- RSD GAMSSA – GMPE reduced by 0.08 K
- 25 km GAMSSA gradients less noisy and compare well with 10 km CMC, although smoother





Australian Government

Bureau of Meteorology

Questions?

Thank You!

Contact: helen.beggs@bom.gov.au

